**Preliminary Hazard Evaluation**
**Optical coupler development, testing, and demonstration**
**CDF Nd:YAG laser**
**Tim Miller and Dave Baird**

## Survey information

09/21/2001 @ 10 a.m.
Lab B Laser Room
Tim Miller, Dave Baird, Martha Helfin, Ken Schultz, Jim Ellermeir, Bob Kephart, Doug Glenzinski

## Operation description

Work will involve (1) assembling couplers, (2) testing effectiveness of laser system to vaporize epoxy, and (3) demonstrating laser system to management representatives. This is expected to be a short-term operation that may start as early as next week. Three different applicators will be coupled to the laser – straight, right angle, and fiber bundle. The bundle is a novel device and may require substantial development effort.

Following successful demonstration, the laser system will be moved to CDF for immediate application in unplugging 4 mm epoxy-blocked aluminum cooling pipes. Future interesting applications are envisioned.

## Preliminary hazard evaluation

The operation will involve use of a class 4 repetitively-pulsed Nd:YAG industrial laser. Typical operation will involve output levels on the order of 10-40 W, though outputs of 100-200 W will be attainable. Under worst-case conditions, this device is capable of exceeding ocular and dermal exposure limits within 10 ns and 0.4 ms, respectively. Injury thresholds would be exceeded within about 10X these durations.

On the positive side, the laser will be a commercial industrial device engineered for safe use by everyday workers. In particular, an internal low power HeNe laser is used to align the beam prior to firing the high output Nd:YAG laser. Additionally, the divergence of the beam from the end of optical fibers is expected to be very large ~12°, so the hazard will drop off very rapidly with distance.

The Lab B Laser Room will be established as the Nominal Hazard Zone (NHZ). Outside of this room will be considered laser hazard class 1 during any anticipated laser operation. This room has a large picture window to the outside and two doorways. Given the very high output of the laser, small light leaks to other areas could be important (e.g., ventilation grill).

## Preliminary safety advice

1. *Light tightness* - Lab B Laser Room must be sufficiently light tight to preclude exposures exceeding hazard class 1 outside of the room. The most obvious measure is to cover the picture window with a material that is both sufficiently opaque and resistant to damage from the beam. After the window is blocked, someone should look for light leaks in the darkened room. At a minimum, obvious leaks that are likely to subject individuals to laser radiation outside of the room should be blocked.

2. *Protective eyewear* – Appropriate laser protective eyewear must be continuously worn by all individuals within the Laser Room during any unenclosed operation of the class 4 Nd:YAG laser. This is the first and **best way** for laser operators to prevent a laser eye injury.

3. *Locked/Interlocked* – Since the Laser Room is being used to reduce the hazard class, it must be locked or interlocked to prevent inadvertent access by unauthorized individuals during operation.

4. *Authorized individuals* – In order for people to be present during unenclosed operation of the laser they need to be a qualified laser operator. A qualified laser operator is someone who has received laser safety training, has completed a laser eye exam, has permission to operate the laser from its "owner", and has familiarized themselves with the hazards of the particular laser system(s).

   Others may be present in "escort fashion" as laser spectators. At least one qualified laser operator must be present at all times who will assume responsibility for the laser safety of the spectator(s). The spectators must be provided with a pre-operational safety briefing and be provided with any necessary safety equipment. In particular, appropriate laser protective eyewear must be supplied and used during any unenclosed operation of the class 4 Nd:YAG laser.

5. *Signs* – Laser radiation danger signs must be posted where they best serve to warn onlookers. In this case, the outside of the north doorway that is intended to be the primary access should be posted with a sign that looks something like the following.

   The ES&H Section has blank laser signs that include the word "DANGER" and the international laser hazard symbol. You may only need 1-2 signs for your situation.

   The sign should only be posted when the hazard is present. Adhesive magnetic strips or Velcro work well for intermittent posting situations.

6. *Labels* – Self-adhesive labels are attached to laser system and laser system enclosures to serve as inventory stickers and to allow the Laser Safety Officer to adjust the hazard classification in accordance with the particular situation. These are provided by the ES&H Section.

| | |
|---|---|
| **NOTICE**<br>THIS DEVICE HAS A LASER RADIATION HAZARD CLASS OF *(system class as used)*<br>ASSESSED ON *(date)*<br>BY *(name)*<br>X4646 ES&H SECTION | **Starburst symbol**<br>*(laser seq #)* |

7. *Written operating procedures* – Written operating procedures must be prepared by CDF personnel and approved by the LSO for class 4 laser systems. A standard Fermilab hazard analysis is a good way to accomplish this requirement. Though not requiredm it is not unusual for the applicable D/S head to also approve operating procedures for class 4 lasers. A copy of the procedures must be kept with the laser equipment for reference by the operator and other personnel.

8. *Emergency procedures* – It is a good idea to provide a mechanism for the rapid shutdown and access to class 4 laser systems and associated high voltage

equipment. Otherwise, the Fire Department will be slowed or placed at unnecessary risk in the event of an emergency response. In long-term situations, this is often accomplished via “crash buttons” and/or interlocked exits. For short-tem operations, the presence of multiple qualified personnel is typically adopted. The emergency procedures should be reflected in the written operating procedures.

9. *Energy dissipation* – Where this class 4 laser is capable of thermally decomposing materials, provision must be made to safely dissipate the unused power.

10. *Beam intensity vs distance* – Since the divergence of the beam from the end of the fiber optic provided with the laser is large (~12°), the hazard decreases rapidly with distance. ***[NEEDS ADDITIONAL WORK]***

11. *Diffuse scatter* – ***[NEEDS ADDITIONAL WORK]***